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ABSTRACT

This study addressed problems of context organization and learning mediators in planetarium classrooms by testing a hypothesis that advance organizers and clustering singly and in combination would be more effective learning mediators than traditional planetarium instruction lacking these mediators. Subjects (N=832) received one of four treatments involving the same subject matter: (1) traditional lecture presentation; (2) instruction with clustering; (3) instruction with advance organizers provided by the planetarium teacher; and (4) instruction with clustering and with advance organizers provided by the planetarium teacher. Posttest results indicated that advance organizers and clustering applied singly improved results of instruction when compared with a traditional planetarium presentation not utilizing these mediators, suggesting their incorporation into planetarium presentations. (Author/SK)

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INVESTIGATING LEARNING MEDIATORS IN THE PLANETARIUM CLASSROOM

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Introduction

School planetariums have been in use for nearly fifty years creating many questions regarding their effectiveness as an instructional tool. Previous studies such as the Wright (1970) investigation have detected no measureable effect on learning astronomy concepts when classroom activities were followed by planetarium instruction. Giles (1981) found teaching strategies seriously affect the learning outcome in a planetarium setting. Waneking (1970) suggested that planetarium educators were more concerned with performance of equipment than evaluation of teaching performances. Later, Heyedes (1972) found planetariums were effective teaching instruments in programs for improving listening skills. Identifying, verifying, and classifying were aided by teaching in a planetarium. In these earlier studies there were no tests of the psychology of learning.

Many veteran planetarium teachers adjust their teaching by trial and error which is the most inefficient method of curriculum design.

This investigation ignored the earlier interest in planetarium projections and subject matter content of school planetarium classes. The study addressed the problems of content organization and learning mediators. The particular learning mediators investigated included use of advance organizers. Many experienced planetarium teachers limit the numbers of concepts included in each lesson, but their reasons were largely intuitive instead of empiracle.

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Another practice of experienced planetarium teachers has been the preentry lesson or preentry introduction to the science lesson. In this time of budget cutting the planetariums that are providing an efficient learning program are proving their value.

Sunal (1976) reported that planetarium operators indicated that an orientation lesson before planetarium entry improved learning gains during the planetarium lesson. Wright (1970) detected no effect on learning by planetarium activities following classroom teaching. Smith (1974) found that the time spent in the planetarium was directly related to achievement test outcomes after the lesson. Chamberlain (1970) reduced planetarium achievement to effectiveness in reaching behavioral objectives that were evaluated through concrete, observable, and trainable behaviors.

Lange and Jackson (1974) employed a sorting recall procedure that tested the clustering of concepts in free recall. A high correlation occured between recall scores and clustering scores. Ausubel (1970) indicated that organizers aid the learner's grouping of concepts into chunks that the learner can manage in the short term memory. Novak (1970) applied this advance organizer theory to the teaching of Biology.

Novak (1979) found that learning became more meaningful when instruction was planned to encourage subsumption, integration, superordinate learning, and progressive differentiation through the use of advance organizers. It was found that advance organizers are not concepts taught to motivate learning, but instead are facilitative of meaningful learning. DiVincenzo (1979) pointed out clustering improved the measured performance of slower learners to the greatest extent.

The purpose of this investigation was to test the hypothesis that advance organizers and clustering singly and in combination were more effective learning mediators than the traditional planetarium instruction in which these mediators are not used.

Method

Subjects

The sample consisted of 832 high school science students enrolled at a Pennsylvania public school. The pupils ranged in age from 15 to 16 years and came from a medium income suburban Pittsburgh families.

Procedures and Materials

The students were enrolled in thirty-six class sections in three ability level tracks. Three sections were randomly selected from each track to be given the four treatments. The treatments included the control, advance organizers, clustering, and the latter two treatments in combination. The experimental design was a non-randomized control group pretest/posttest (Van Dalen, 1966).

Internal consistency reliability was determined through the use of the Kuder-Richardson formula 20 using posttest data of a pilot project yielding a value of 0.74. The value for the investigation instrument yielding a KR-21 value of 0.84. The increase in the reliability figure was attributed to the rejection of ten of the weakest items of the pilot instrument and the increase of sample size in the investigation compared to the pilot study.

Treatments

The exact treatments consisted of traditional lecture style of presentation at a planetarium along with presentations designed to improve student learning through planetarium education. The treatments included (1) a traditional lecture presentation in the planetarium, (2) instruction in the same subject matter with clustering, (3) instruction in the same subject matter but with advance organizers provided by the planetarium teacher, and (4) instruction in the same subject matter with clustering and

with advance organizers supplied by the planetarium teacher. Three class sections from each track level were taught in each treatment. Track 1 students had the top third reading scores, and track 3 comprised the bottom third of the reading scores.

The investigator presented the treatments to all sections of the pupils insuring a uniformity of the instruction to provide internal validity of the study. In order to assure external validity all groups received all testing and treatments in the planetarium chamber, thus eliminating variables inherent in setting differences. The reactive effects (Isaac and Michael, 1975) of the experimental procedures were diminished through telling the subjects that the study was seeking statistical data about planetariums without regard to individual learning or individual performances.

The characteristics of the treatments were as follows:

1. Control - a taped lecture without clustering or advance organizers.

2. Clustering - No advance organizers were presented to the students; however, a taped lecture was presented with a clustering of concepts.

3. Advance organizers - slides illustrating basic geometric shapes were presented before the taped lecture that contained no clustering.

4. Advance organizers with clustering - Advance organizers (treatment 2) were supplied to the students and the concepts were clustered (treatment 2) in the presentation.

5. All the treatments were preceded by pretesting and succeeded by posttesting following one week after the treatment.

Results

The means of the various academic tracks in the four treatments indicated a possible relevence of the mediators to efficiency of the instruction. The means are summarized in Table I.

Table I

Means of Posttest scores on the Achievement Test

Ability levels Track	Control	Clustering	Advance Organizer	Advance Organizer and Clustering	$\overline{X}$ Row
High	(267)* 9.08(60)	11.08(69)	10.84(76)	14.09(62)	11.27
Middle	(286)* 11.09(64)	9.52(72)	11.61(75)	13.58(75)	11.48
Low	(284)* 5.79(67)	9.50(71)	9.27(73)	8.60(73)	8.27
	$\overline{X}$ = 8.60	$\overline{X}$ = 10.02	$\overline{X}$ = 10.51	$\overline{X}$ = 12.00	Grand Mean
					$\overline{X}$ = 10.38

* n of samples

The means of the academic tracks in the various treatment groups were subjected to analysis of variance comparing the posttest results produced by the separate treatments. It was indicated the treatments did indeed cause significant differences in the learning outcomes, ($p < .05$).

Table II

Two Way Analysis of Variance of Posttest Means

Souce	Sum of Squares	DF	Mean Squares	F ratio
Treatment	1252.80	3	417.60	25.48 *
Levels	1172.46	2	586.23	35.77 *
Interaction	2425.26	5	485.05	29.59 *
Error	11702.60	714	16.39	

* $p < .05$

The Duncan Multiple Range test indicated that a significant difference in posttest means existed at the $p < .05$ level among both treatments and academic tracks. Suprisingly the organizer model of instruction was not significantly different in its results from the clustered model of instruction. Further the method of tracking according to results of the Iowa Basic Achievement Test for reading had actually produced only two significantly different ability level tracks.

Table III

Duncan's Multiple Range Test for Significance

Between Means of Posttest

	$p < .05$	DF = 718	MS = 16.41
Treatment	4	(Advance organizers and clustering)	
Treatments	3 and 2	(Organizer or clustering)	
Treatment	1	(Control)	
	2 and 1	(High and middle tracks)	
	3	(Lower track)	

Therefore the comparisons drawn in the research were basicly between the upper half and lower half according to academic placement.

The GLM is summarized in table IV and V. It shows the pretest scores were not the predominant influence in determining the posttest scores for the various treatments.

Table IV

GLM Summary of Pretest - Posttest Comparison

Source	DF	Mean Square	F	R Square
Interaction	1	3833.8797	266.44*	0.2696
Error		14.3893		
*Significant				

* $p < .05$

Table V

Linear Regression Summary of Pretest versus Posttest Scores

Source	DF	Type I	S S	F Value	DF	Type IV	S S	F Value
Pretest	1	3833.8	796	266.4	1	3833.8	796	266.44
Parameter	Estimate	t for Parameter = 0				Std error of estimate		
Intercept	7.013	27.43*				.2556		
Pretest	.8315	16.32*				.0509		

* $p < .05$

The real thrust of the results are summarized in table VI. It was evidenced by the Scheffe Method comparisons that the learning mediators could produce gain in efficiency of instruction in a planetarium classroom. The lowest track of the subjects was able to achieve learning, as indicated by achievement tests, that was not significantly less than learning by the highest track instructed through traditional lectures in the planetarium.

Table VI

Summary of Scheffe Comparisons of Posttest Means

Clustered	Track 2	versus	Organizer	Track 2	not sig
Clustered	Track 2	versus	Clustered	Track 3	not sig
Control	Track 1	versus	Organizer	Track 3	not sig
Organizers	Track 3	versus	Clustering	Track 2	not sig
Organizers	Track 1	versus	Clustering	Track 1	not sig
Organizers	Track 2	versus	Hybrid	Track 2	not sig
Hybrid	Track 3	versus	Clustering	Track 2	not sig
Organizers	Track 3	versus	Clustering	Track 1	not sig
Hybrid	Track 3	versus	Control	Track 1	not sig

Conclusions

The purpose of the study was to determine if advance organizers and clustering affected the rates of learning in a planetarium presentation. The results showed that the combination of these factors produced measurable effects on learning in the planetarium.

The treatments included instruction in a planetarium with the subject matter presented with the aid of advance organizers and clustering singly and in combination and a control treatment in which neither of these learning mediators were incorporated in the instruction. These four treatments were presented to students in three academic tracks assigned by school guidance personnel according to the Iowa Basics testing. Each treatment group received pretesting followed by the instructional treatment randomly assigned to that particular class section. The posttesting occured approximately one week after the instructional treatment. All testing and all instruction occured in the same planetarium setting and by the same teacher.

The instrument was designed through a preliminary study carried out in 1978. The pilot study instrument was edited through item analysis to eliminate weaker items and shorten the test. The instrument was composed of twenty multiple choice items. The same instrument was used as a pretest and as a posttest. Item analysis was conducted only on posttest results.

It was indicated that the treatments did make a significant difference in learning. There did not appear to be significant differences between the clustering results and the advance organizer results according to the Duncan comparison. The treatment most effective was the combination of advance organizers with clustering.

Planetarium instruction should be planned to meet the needs of the different ability levels of students. Lower track students should not be evaluated in accord with standards set for average students' learning abilities. The testing should span a spectrum of greater variance of student growth in the evaluation of lower track students. The study indicated that learning mediators did raise performance levels of the lower track groups but individual differences should be examined during evaluation of learning.

The clustering and advance organizer mediators produced equal performance; whereas the combination of these mediators generated better performance than either single mediator. Literature indicated that both of these mediators function to increase the meaning.

The posttest results indicated advance organizers and clustering applied singly improved results of instruction compared with a traditional planetarium presentation not utilizing these mediators. The possible use of other mediators to improve instruction in the planetarium should be investigated. The cumulative effects of combining these mediators was significantly positive upon learning outcomes. Is it possible that addition of other learning mediators to the presentation would improve results of instruction? Since combining these two

mediators improved results of instruction to a greater degree than improvement achieved by either mediator used singly, how many mediators might be combined to optimize the learning?

Instructors should consider combinations of learning mediators to achieve optimum learning. Novak (1980) found evidence of advance organizers having been responsible for higher levels of student clustering in biology. In this study of planetarium instruction advance organizers with clustering significantly improved learning to an extent that the lowest track students in the combined mediator group performed as well as the highest track students not receiving the mediators. The addition of both mediators of learning was significant in improving learning above that achieved by either mediator alone. The combined mediator lesson raised the lowest track group to the performance of the highest track not receiving either mediator.

Results of this study concur with current literature of memory research. This study concurs with Travers (1976) conclusion: Students learn more effectively if aided in creation of logical operations. This study concurs with Tulving's (1972) conclusion: Meaningful learning takes place when teachers rely on student semantic memory rather than student episodic memory. The greater amount of learning produced when students were given advance organizers with clustering during the lesson corroborates Ausubel's (1970) statements that the teacher is an organizer of the learning. The effect of the advance organizer treatment and the hybrid treatment including the advance organizers indicated that the advance organizers did aid the learners' grouping concepts into chunks than were manageable in the STM as predicted by Novak (1980).

When planetarium instruction aids the student's entering subject matter in both episodic and semantic mechanisms of LTM, the students can reconstruct the concepts from linguistic, descriptive, or imaginal sensory impressions from the learning experience (Andre, 1979). The effective teacher will present the concepts to be learned in episodes including several simultaneous inputs of

sensory information while advantageously employing mediators to encourage a systematic entry of the knowledge into semantic memory. After the planetarium experience, the successful learner has the ability to reconstruct impressions from the lesson (Piaget and Inhelder, 1973). This study corroborates these opinions.

The learner might recall the observation of Orion occurring after observing Gemini. The switch to semantic memory involves the series of separate categorized pieces of information that describe Orion.

The learner then constructs an internal picture of Orion with the particular bright stars at various locations over the figure.

By planning and use of advance organizers and clustering, the planetarium teacher may help the student place more information into the Long Term memory about celestial objects or celestial events.

Implications

Since the traditional method of planetarium presentations, learning situations requiring rote learning, produced the poorest achievement, planetarium teachers should incorporate in their presentations the learning mediators, clustering, and advance organizers.

Although only two mediators were examined the superiority of the combined effects over single effects suggests that other learning mediators, in combination with those examined, might produce even better achievement.

Planetarium teachers who do not know how to systematically apply learning mediators to their presentations should be provided training in these methods. Teacher preparation institutions should provide this training through their programs for teacher preparation and inservice improvement.

To be effective preentry activities of a planetarium lesson should satisfy the checklist of characteristics of advance organizers. The findings indicate that the advance organizers intended for all track levels did not have equal

at all levels. In future investigations there should be an attempt to identify those properties of advance organizers that produce greater effects with slow learners and also those factors of advance organizers that produce the greater effects with higher ability groups.

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